

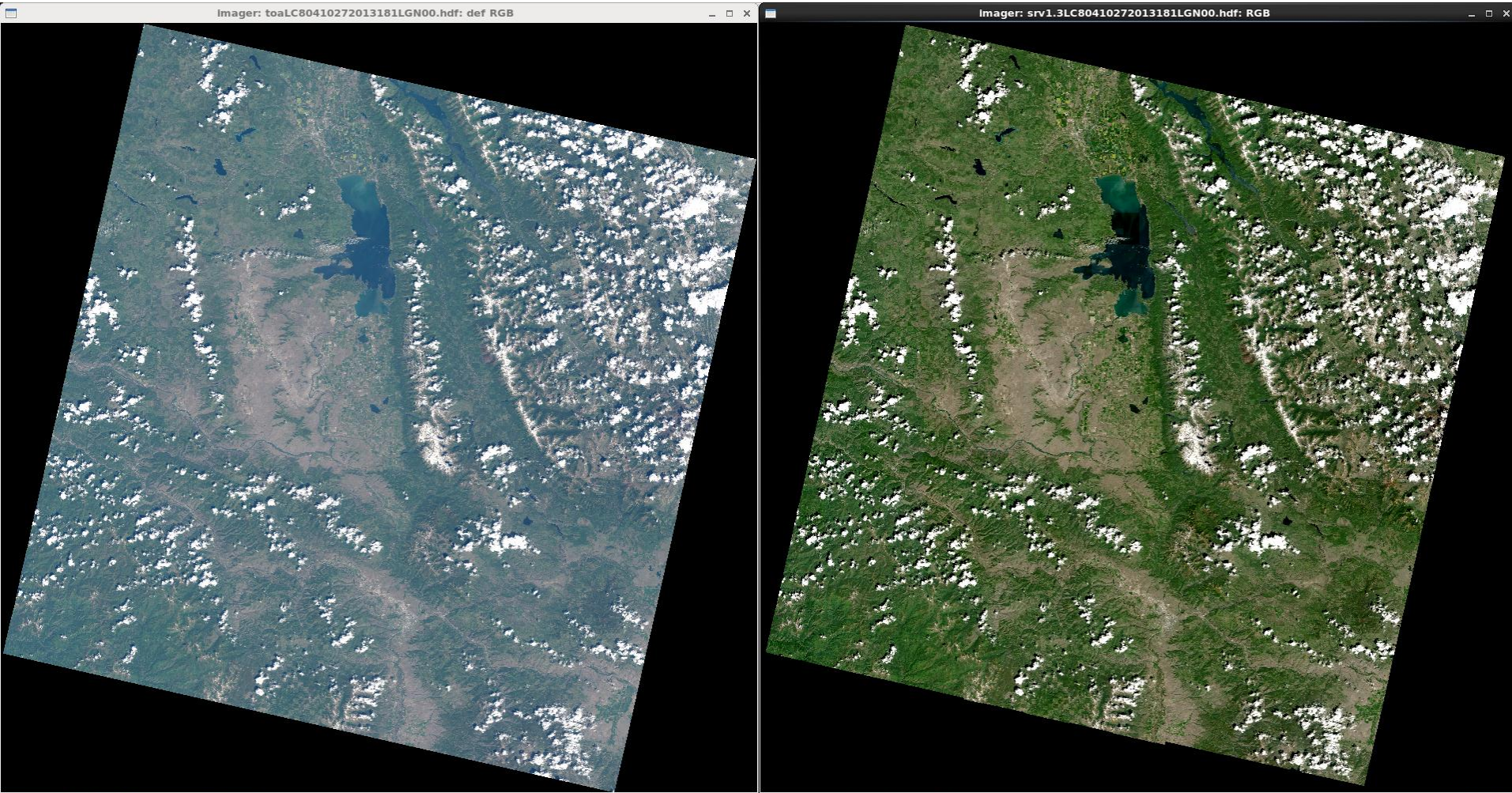
Landsat's and Sentinel-2 surface reflectance product: status and prospective

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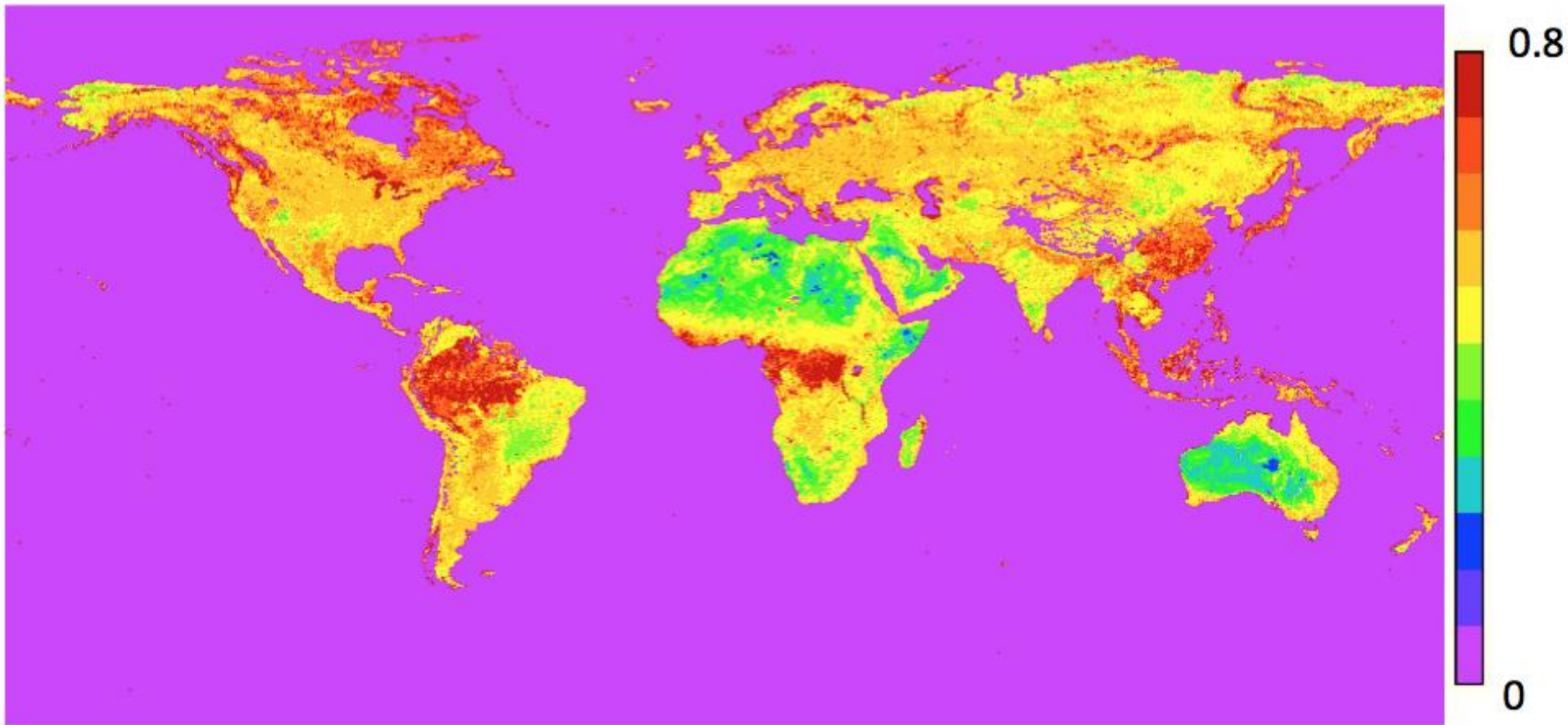
Chris Justice University of Maryland/Dept of Geographical Sciences
Martin Claverie, Belen Franch UMD/GEOG and NASA/GSFC Code 619

EVIDENCE OF ATMOSPHERIC EFFECTS (SCATTERING)



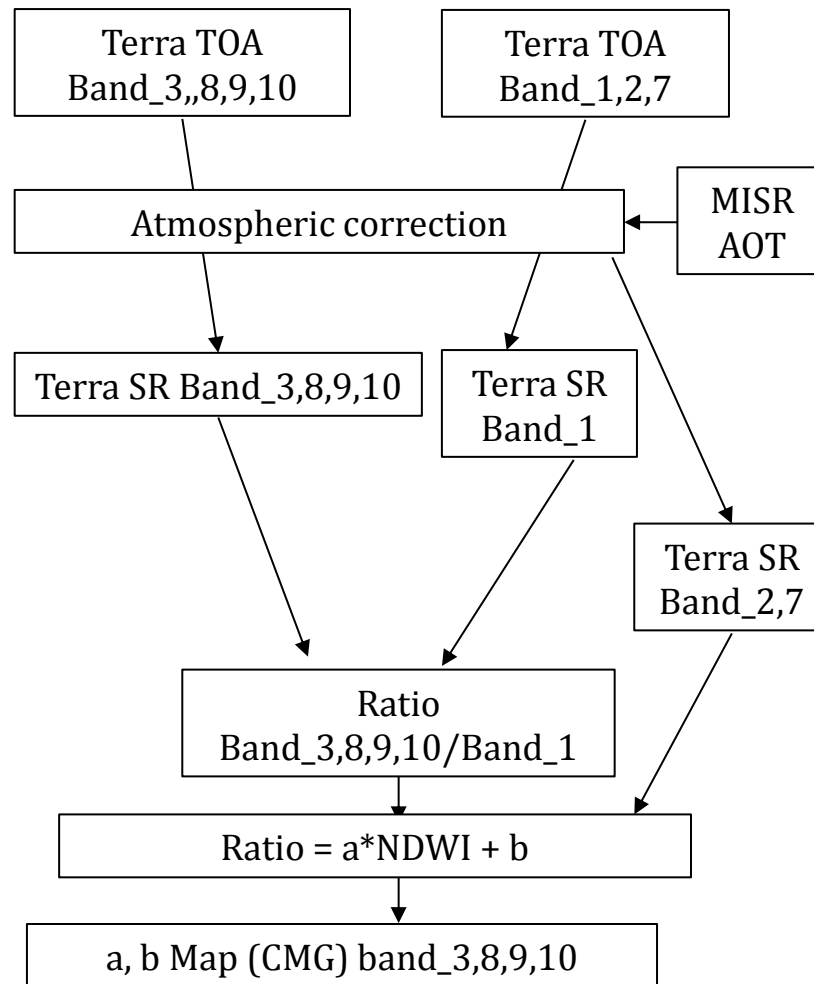
Landsat 8/OLI RGB composite (Red Band04, Green Band03, Blue Band02), over Missoula, MT, acquired on June 30, 2013. The Left side corresponds to the reflectance at the top of the atmosphere, the right side to the surface reflectance. The “color stretch” used for both side is the same.

TOWARD A GENERIC AEROSOL RETRIEVAL/ATMOSPHERIC CORRECTION USING MODIS/MISR ~15 Years record



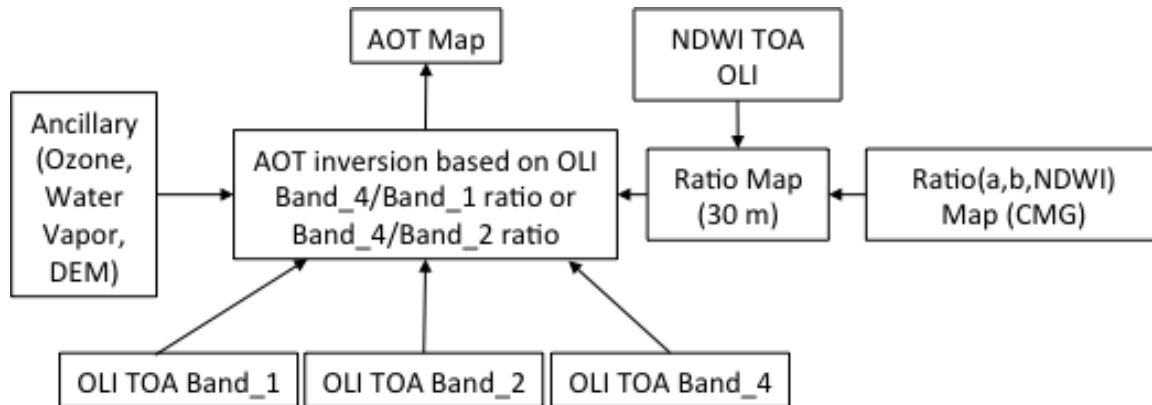
Map of the ratio between MODIS Terra band 3 ($0.47\mu\text{m}$) and band 1 ($0.67\mu\text{m}$). This is the average ratio observed over a period of 10 years using coincident MODIS/MISR observations and the optical thickness from MISR to perform atmospheric correction.

RATIO MAP RETRIEVAL FLOWCHART

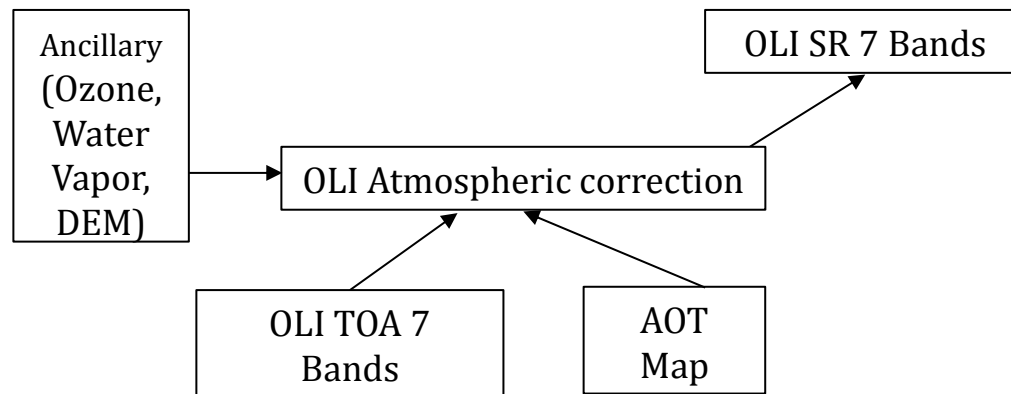


ATMOSPHERIC CORRECTION FLOWCHART

Aerosol retrieval



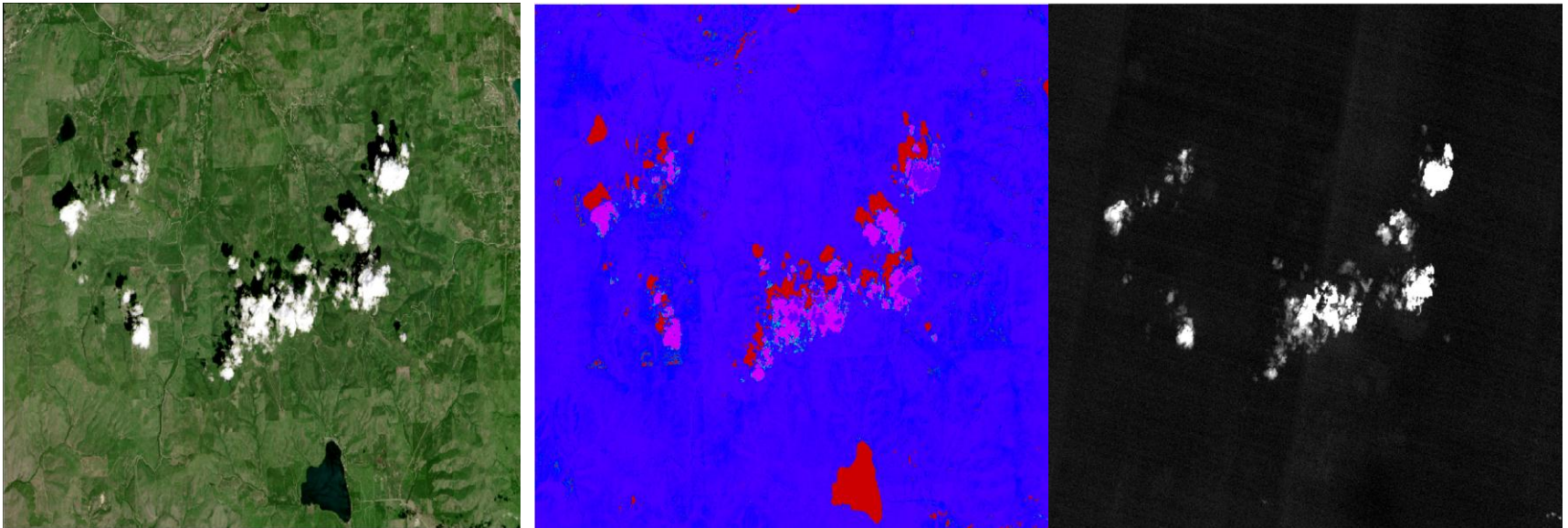
Atmospheric correction



Use of the residual from AOT retrieval for cloud identification

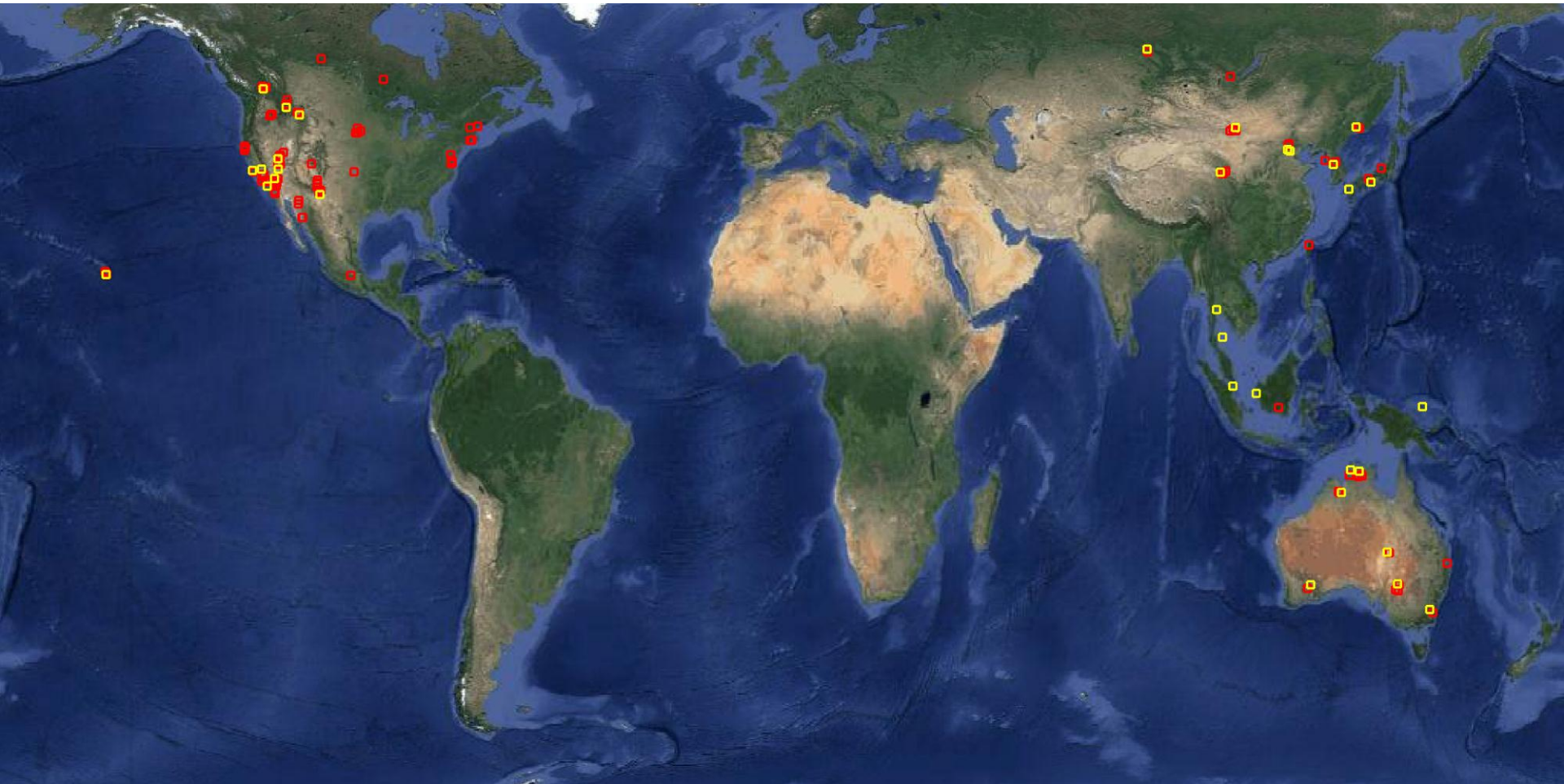
$$Residual = \sqrt{\frac{(\rho_s^1 - r_{1,4}\rho_s^4)^2 + (\rho_s^2 - r_{2,4}\rho_s^4)^2}{2}}$$

Residual is computed from Band 1,2 (blue) and 4 (red) after atmospheric correction using the ratio's ($r_{1,4}$ and $r_{2,4}$) derived from MODIS/MISR.



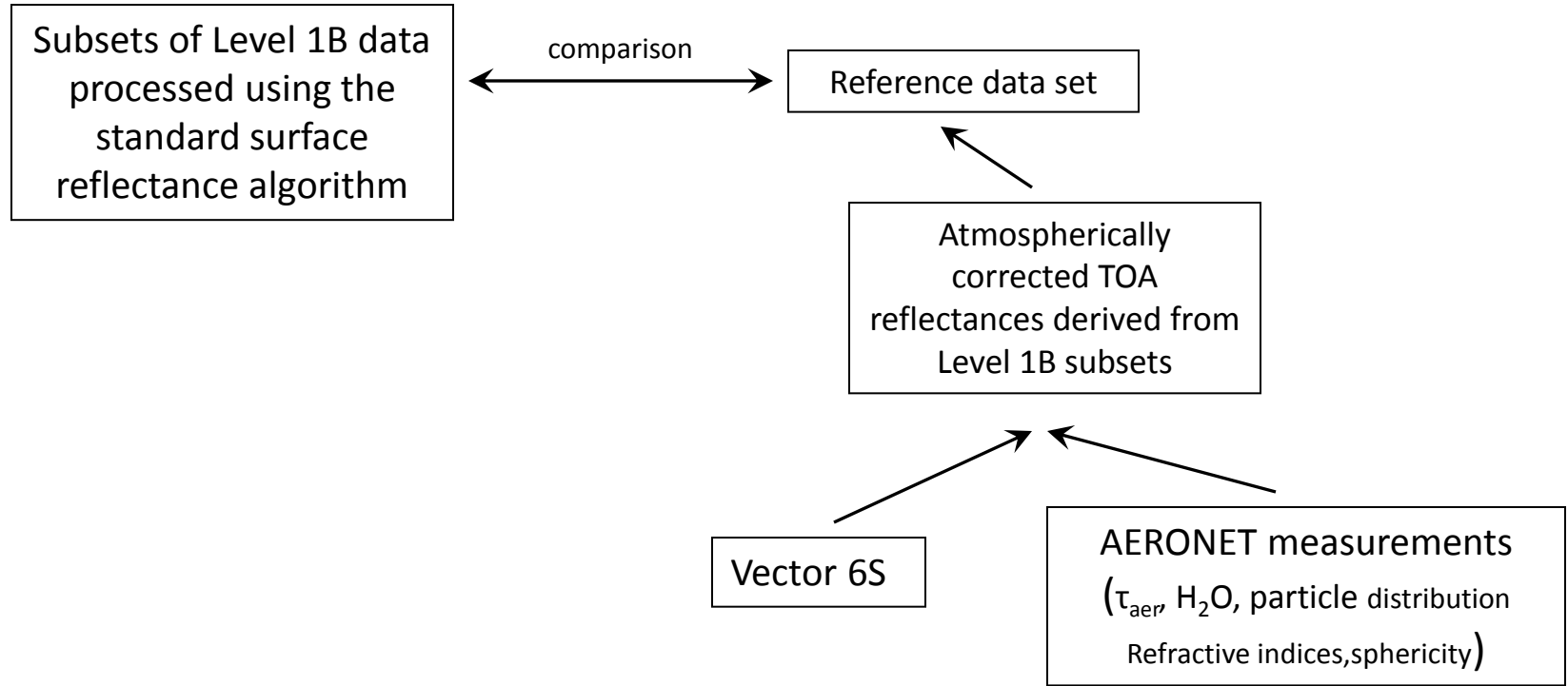
RGB detail of the Missoula scene (left), (center) color scaled residual: the Magenta pixels correspond to higher residual later flagged as cloud, the red were not flagged as cloud but discarded (in that case water and cloud shadow), the purple are clouds flagged early in the processing by the cirrus band (note the threshold on the cirrus band has been set very conservatively ~ 0.02 reflectance unit). (right) Cirrus band 09.

OLI surface reflectance validation: AERONET, MODIS, Flux towers



Map of the AERONET sites (yellow squares) used for the validation and the OLI scenes (red square) used for the OLI-MODIS inter-comparison

Methodology for evaluating the performance of surface reflectance product over AERONET (generic)



Validation Metrics

- Accuracy (A) = the bias

$$A = \frac{1}{N} \times \sum_{i=1}^N \varepsilon_i$$

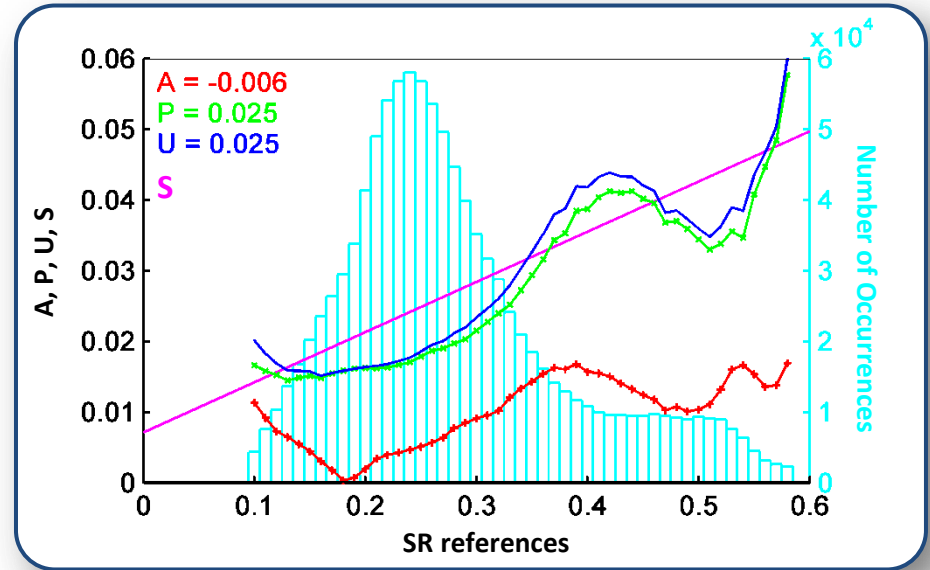
- Precision (P) = the repeatability

$$P = \sqrt{\frac{1}{N-1} \times \sum_{i=1}^N (\varepsilon_i - A)^2}$$

- Uncertainty (U) = the actual statistical deviation

$$U = \sqrt{\frac{1}{N} \times \sum_{i=1}^N \varepsilon_i^2}$$

$$U^2 = \frac{\sum_{i=1}^N (\mu_i^e - \mu_i^t - A + A)^2}{N} = \frac{N-1}{N} P^2 + A^2$$

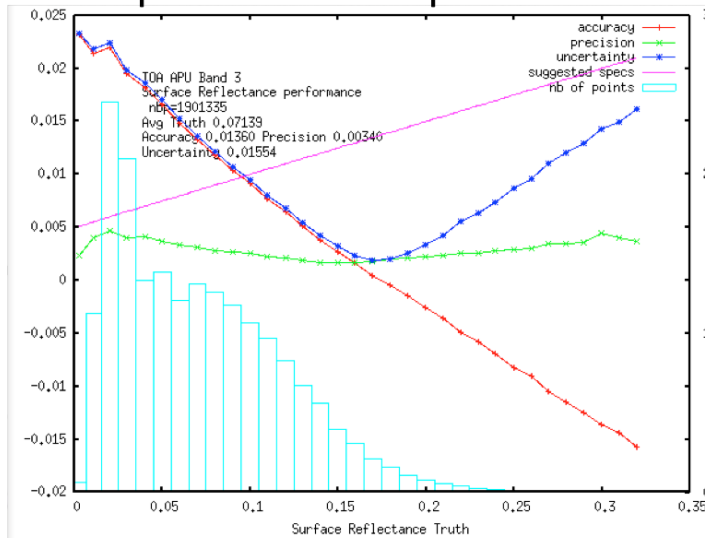


- Specification (S) = Uncertainty requirement

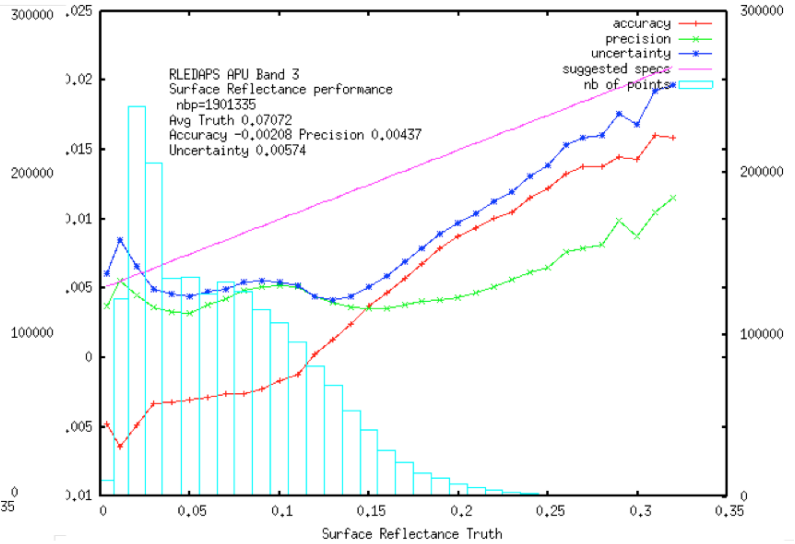
From Vermote and Kotchenova, 2008

APU's FOR RED BAND

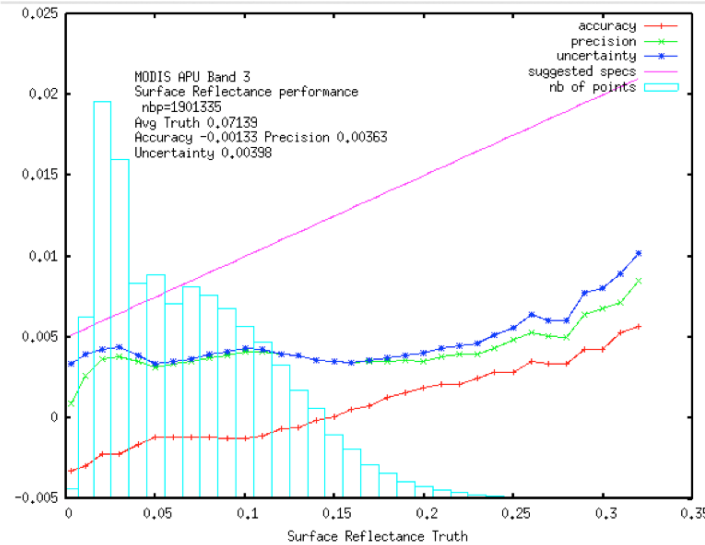
Top of the atmosphere



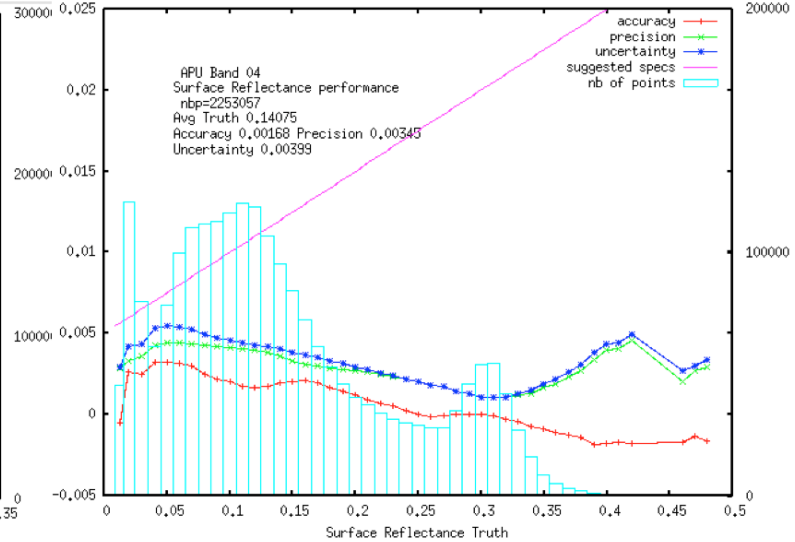
LEDAPS



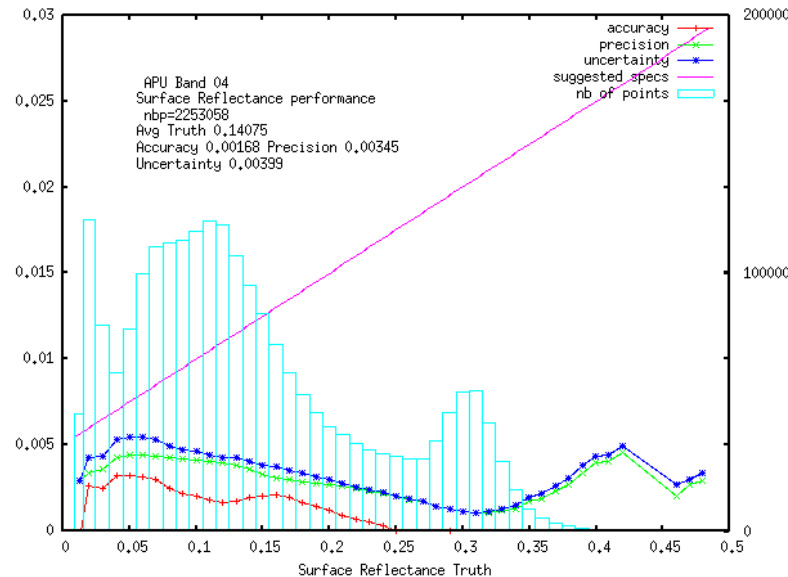
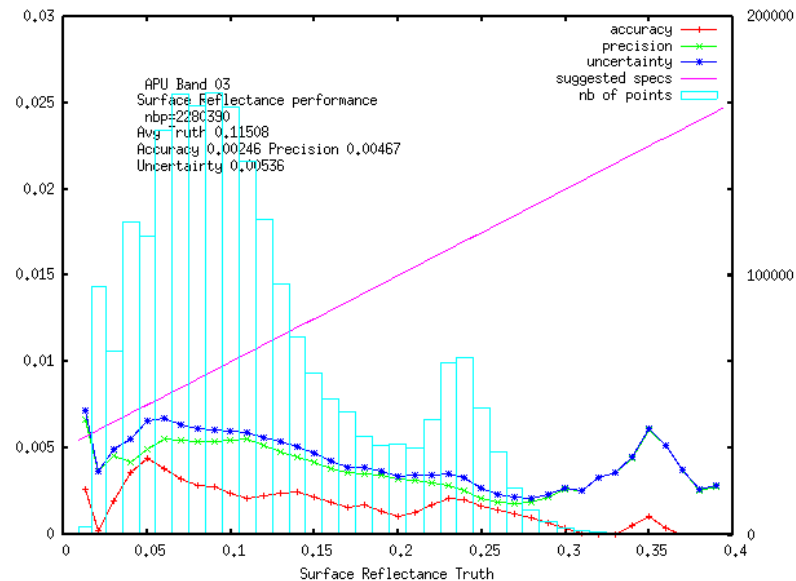
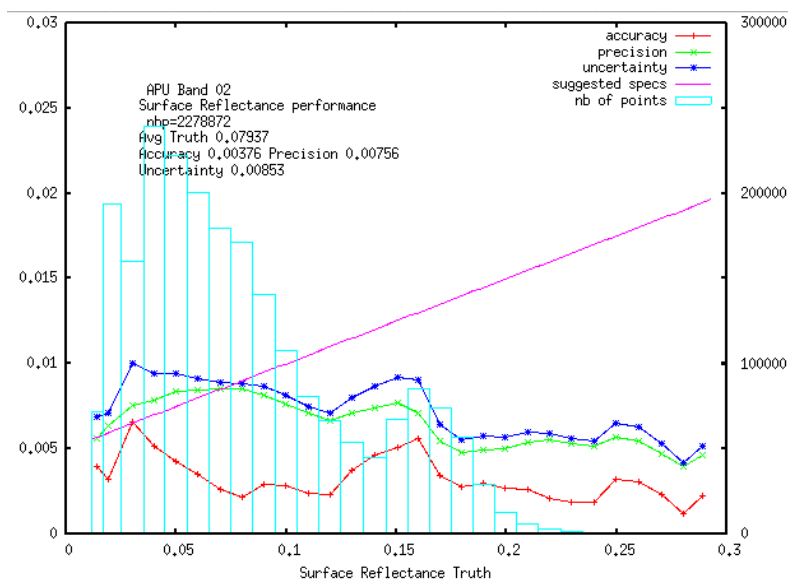
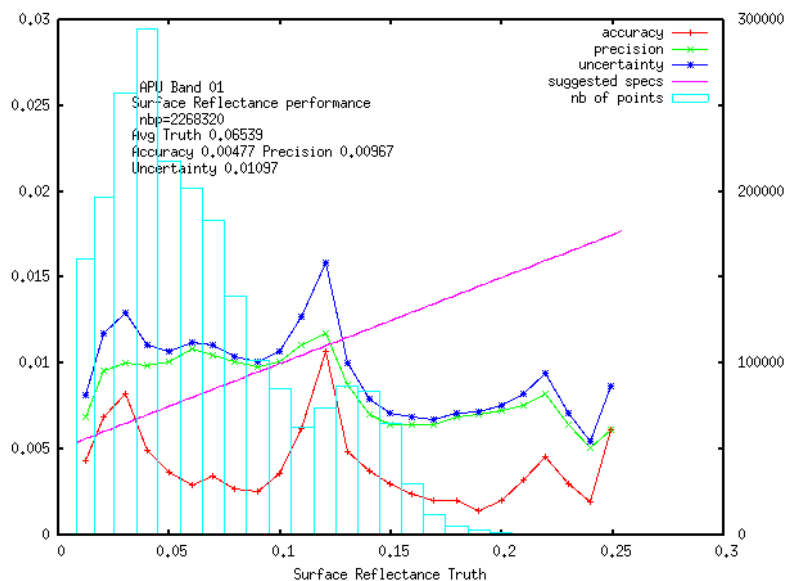
WELD uses MODIS aerosol



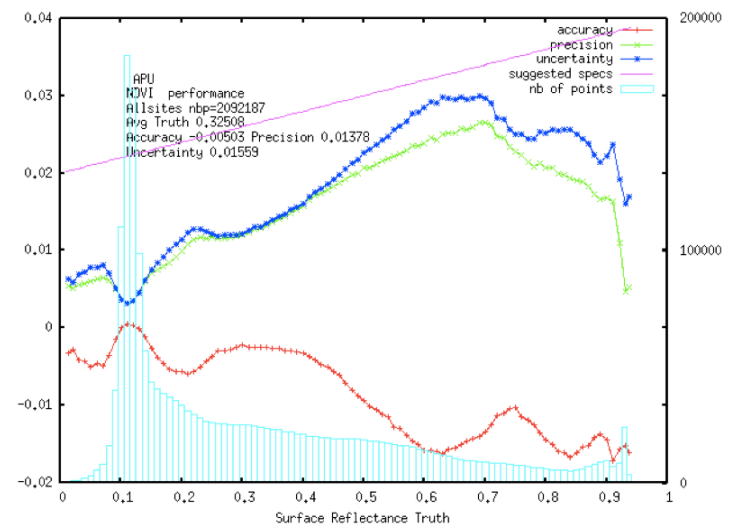
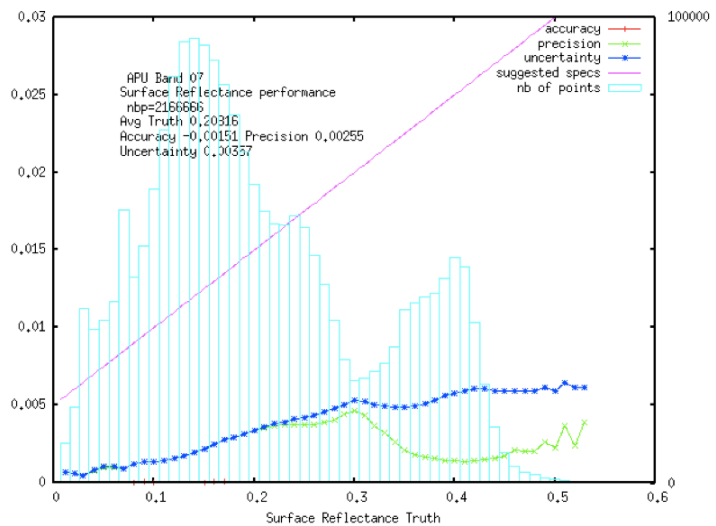
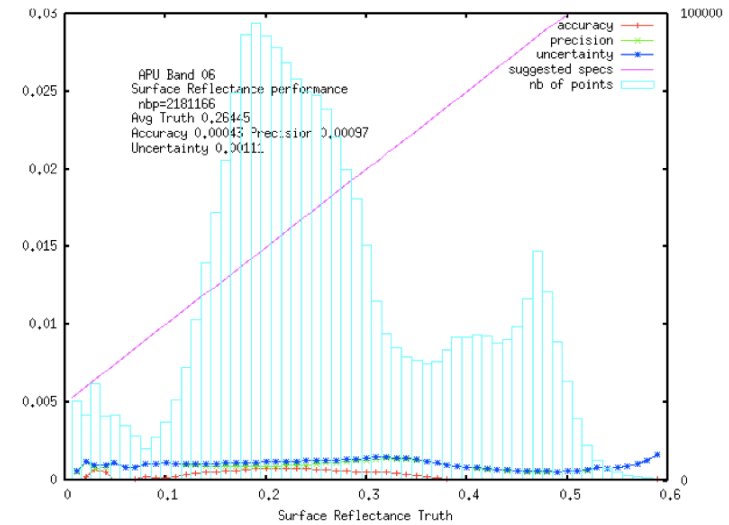
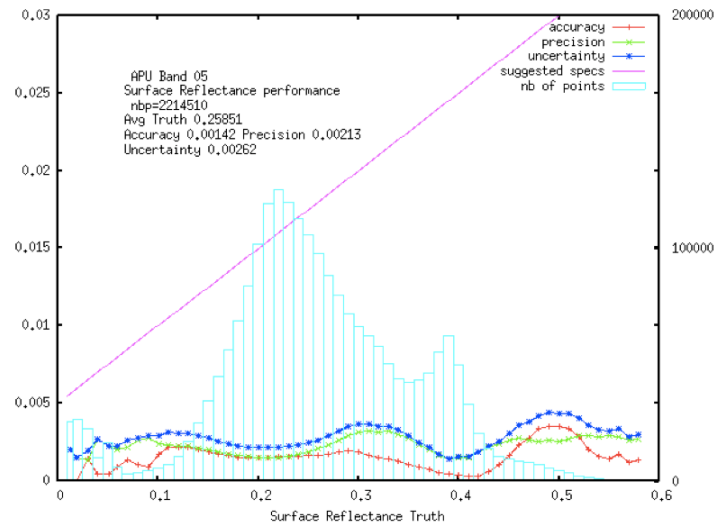
LANDSAT8



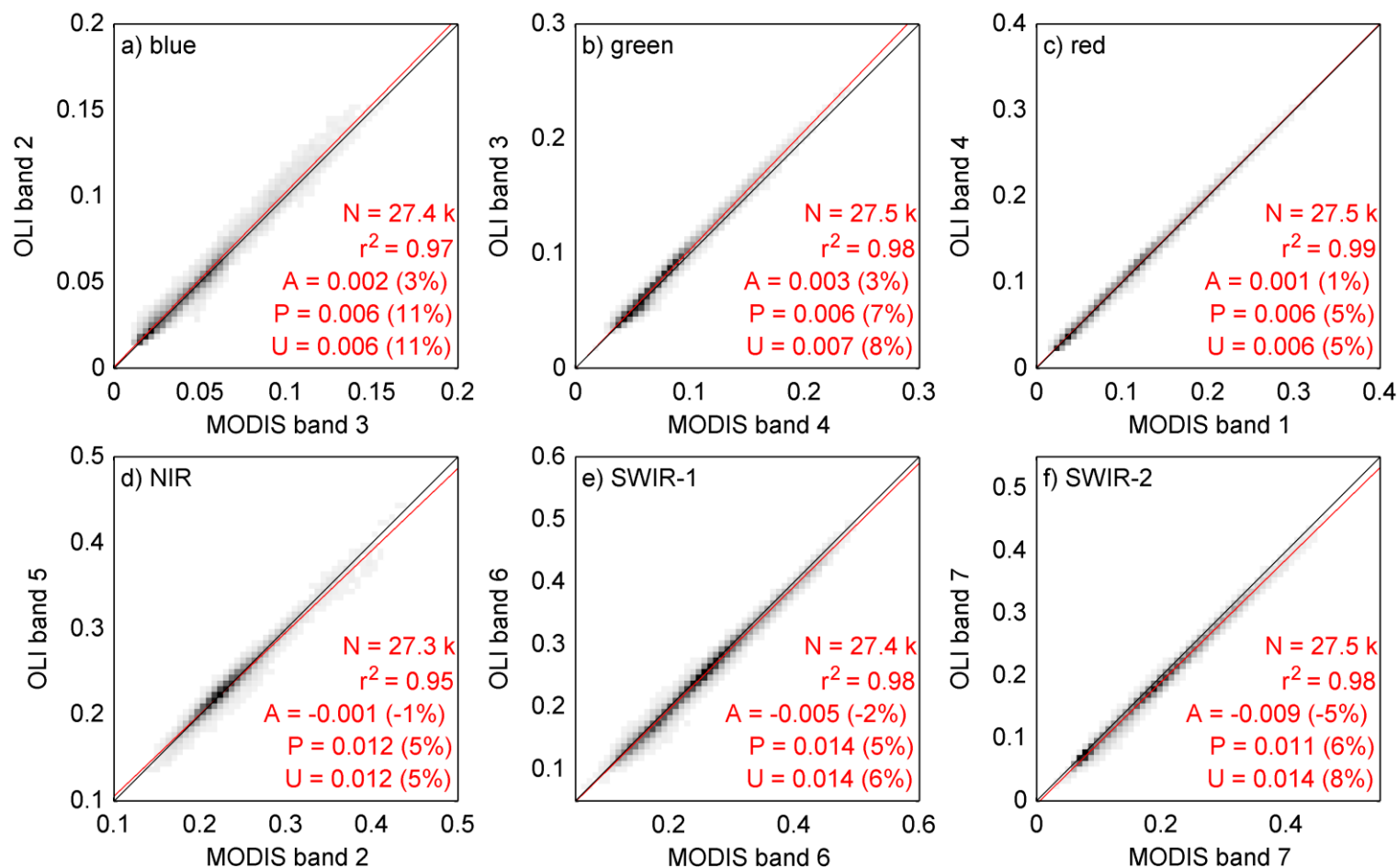
LANDSAT8 SR APU FOR BANDS 1,2,3,4



LANDSAT8 APU FOR BANDS 5,6,7 and NDVI

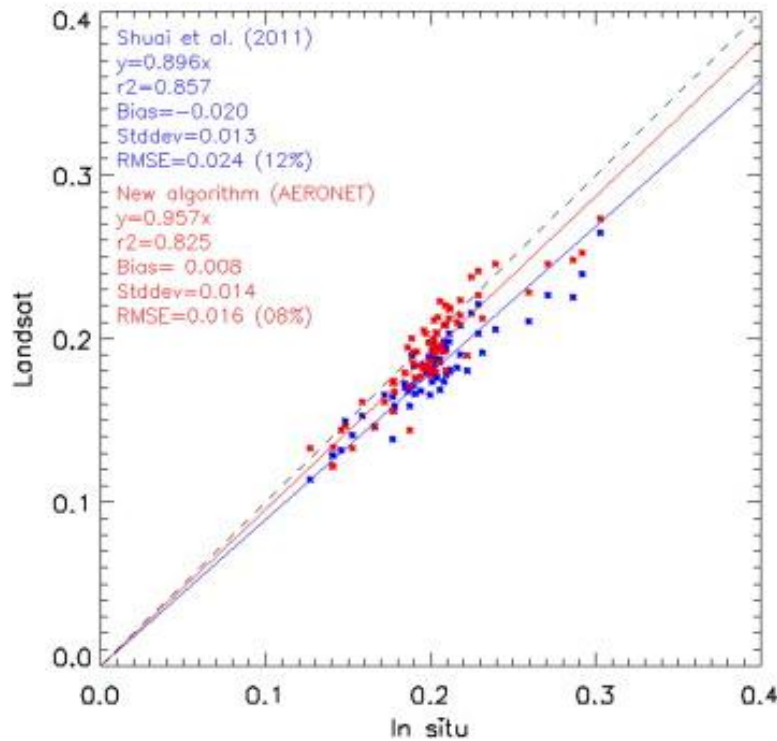


LANDSAT 8 / MODIS CROSS-COMPARISON

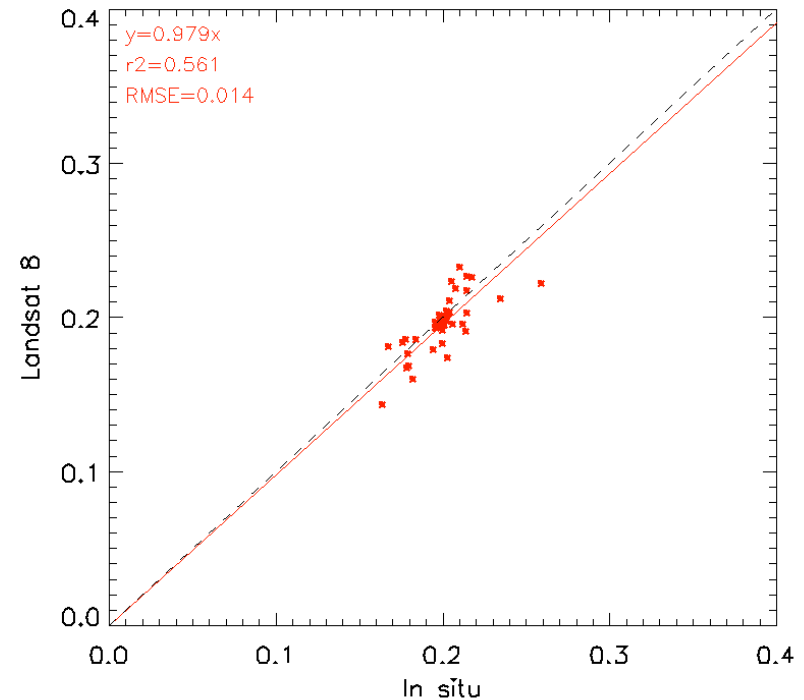


Cross-comparison between Aqua MODIS BRDF and spectrally adjusted SR CMG product and OLI SR aggregated over the CMG. The six subplots correspond to six OLI spectral bands used for the cross-comparison. Plots are represented through density function from light gray (minimum) to black (maximum); white means no data. Red lines correspond to the linear fits. r^2 . Relatives A, P and U are reported under bracket. N is the number of points

LANDSAT 8 ALBEDO ANALYSIS



Validation of Landsat (5/7) Albedo derived by Shuai et al. (2011) and Franch et al. (2014). Note that Franch used AERONET data to improve the surface reflectance of the LEDAPS reflectance product used as input. (From Franch et al. 2014.)



Same as left side but for Landsat8 Albedo, no AERONET data were used to improve the surface reflectance product

CONCLUSIONS AND FUTURE STEPS

- **Landsat8 SR is performing very well benefiting from MODIS collection 6 improvements and extra aerosol band (band1)**
- **The approach is generic and easily transferable to Sentinel 2 data**
- **Some minors improvements are needed (mainly cloud and cloud shadow mask)**
- **An algorithm for retrieval over water including coastal and inland waters will be implemented (in collaboration with S2 team)**
- **We will also investigate the need for a deep-blue (410nm) for future missions to**
 - **Improve LSR retrievals over bright targets (including snowfields, deserts sites, urban/industrial areas)**
 - **Improve retrieval of colored dissolved organic matter (CDOM) in coastal/inland waters for enhanced understanding of carbon cycle**